VT versus SVT

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- Oct 8, 2024

Regular broad complex tachycardias can be ventricular (VT) or supraventricular (SVT with aberrancy) in origin, and differentiation between the two will significantly influence management of your patients.
Unfortunately, the electrocardiographic differentiation of VT from SVT with aberrancy is not always possible.

Differential diagnosis of regular broad complex tachycardia

- Ventricular tachycardia (VT)
- Supraventricular tachycardia (SVT) with aberrant conduction due to bundle branch block
- SVT with any metabolic disturbance that slows supraventricular action potential propagation — hyperkalaemia, sodium channel blockade, severe acidosis
- Antidromic AVRT — re-entrant tachyarrhythmia seen in Wolff-Parkinson-White syndrome
- Accelerated idioventricular rhythm (AIVR)

ECG features increasing the likelihood of VT

Electrocardiographic features that increase the likelihood of VT include:
Absence of typical RBBB or LBBB morphology
Extreme axis deviation ("northwest axis"): QRS positive in aVR and negative in I and aVF
Very broad complexes > 160ms
AV dissociation:

- P and QRS complexes at different rates
- P waves are often superimposed on QRS complexes and may be difficult to discern

Capture beats: Occur when the sinoatrial node transiently "captures" the ventricles in the midst of AV dissociation, producing a QRS complex of normal duration
Fusion beats: Occur when a sinus and ventricular beat coincide to produce a hybrid complex (see Dressler beat)

SHOUT
SHARE
IT

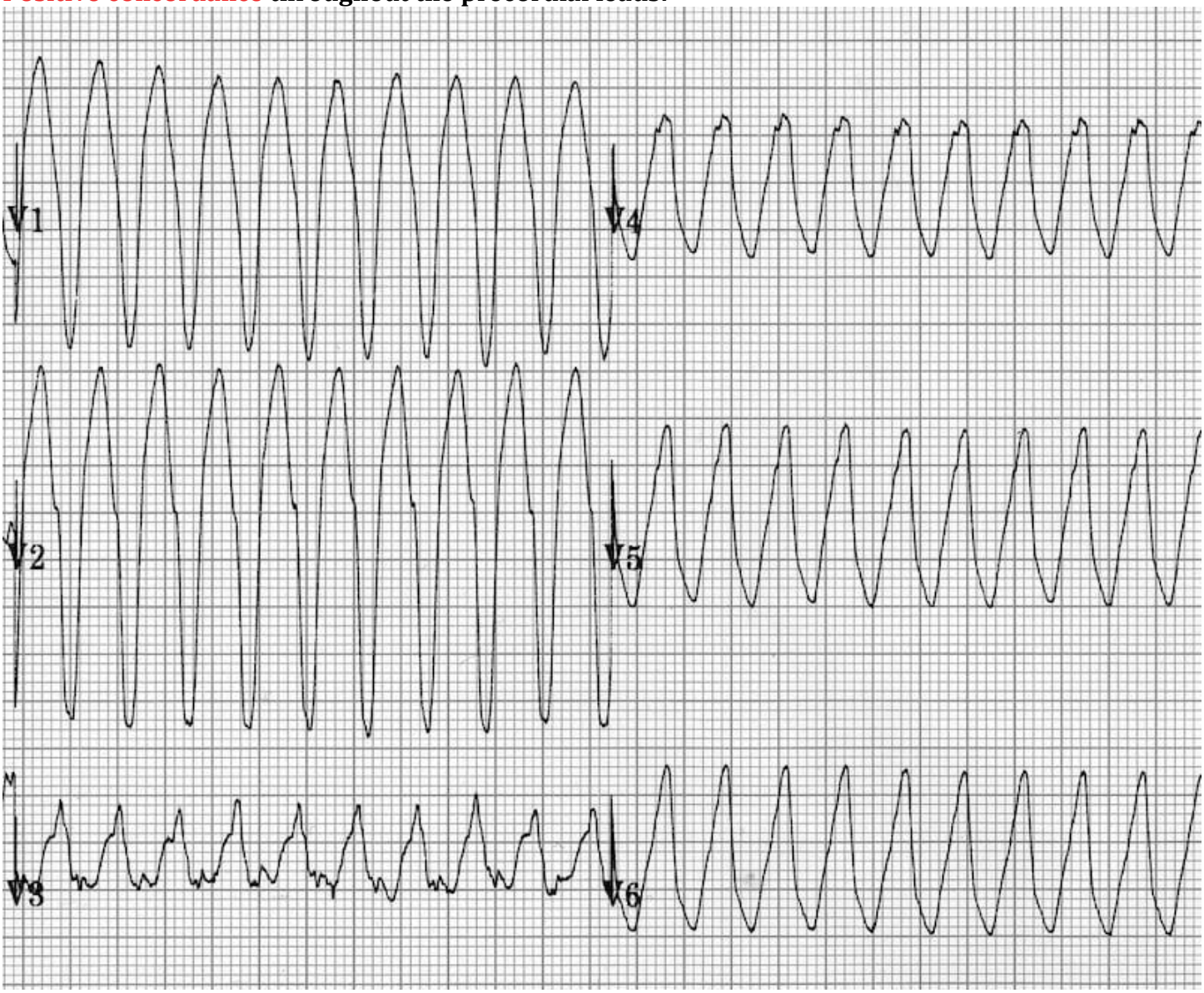
Ventricular tachycardia with fusion beats and capture beats

The QRS complex is wide (grid not shown) and appears as something between the ventricular beats and the normal beats (seen to the right). This is a **fusion beat**.

These beats are presumably supraventricular beats that managed to get through and depolarize the ventricles. They are called **capture beats**. Note that these beats display large Q-waves (which indicates prior myocardial infarction).

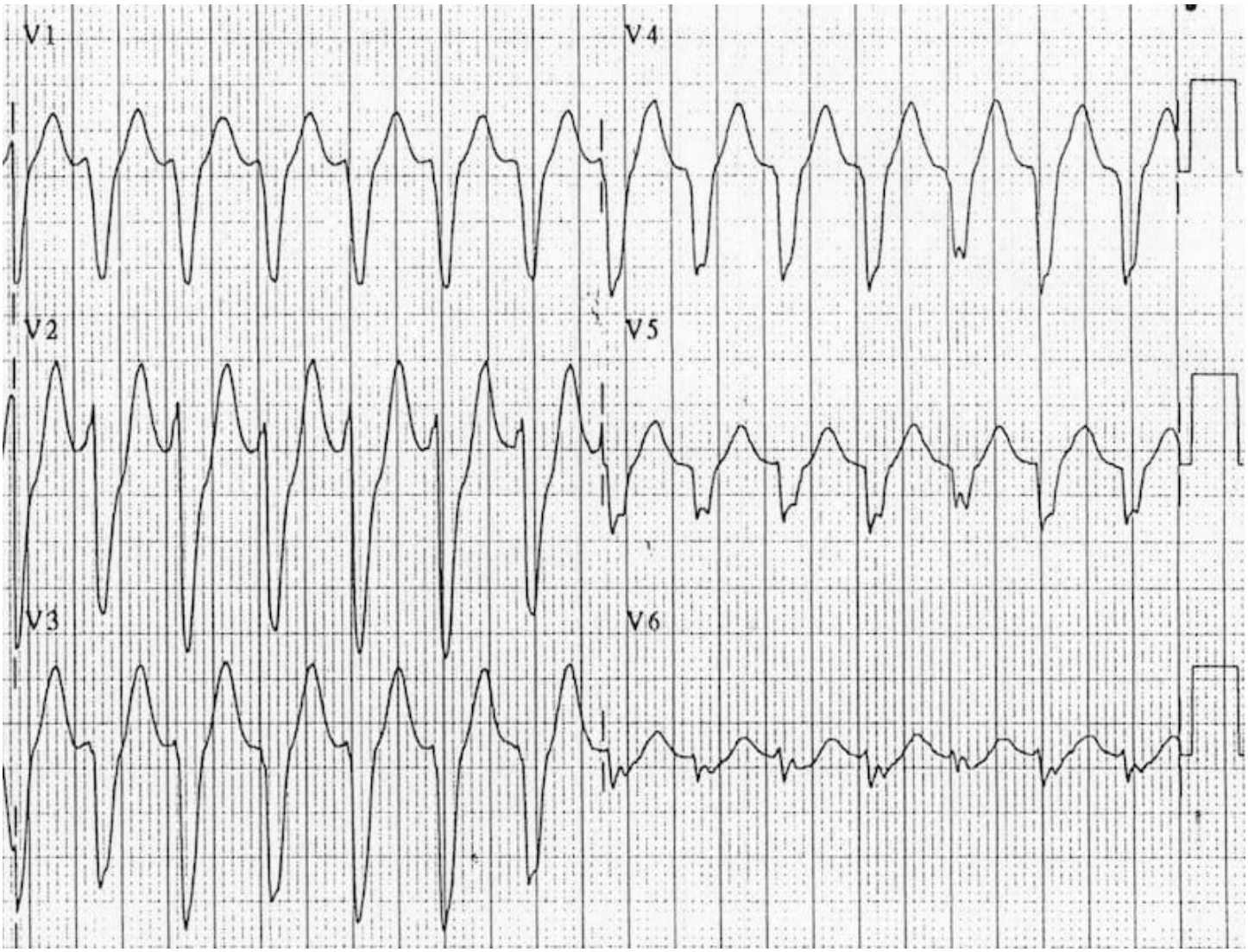
Source ECG waves

Positive concordance throughout the precordial leads:



Positive concordance in VT: Leads V1-6 show entirely positive (R) complexes, with no rS complexes seen

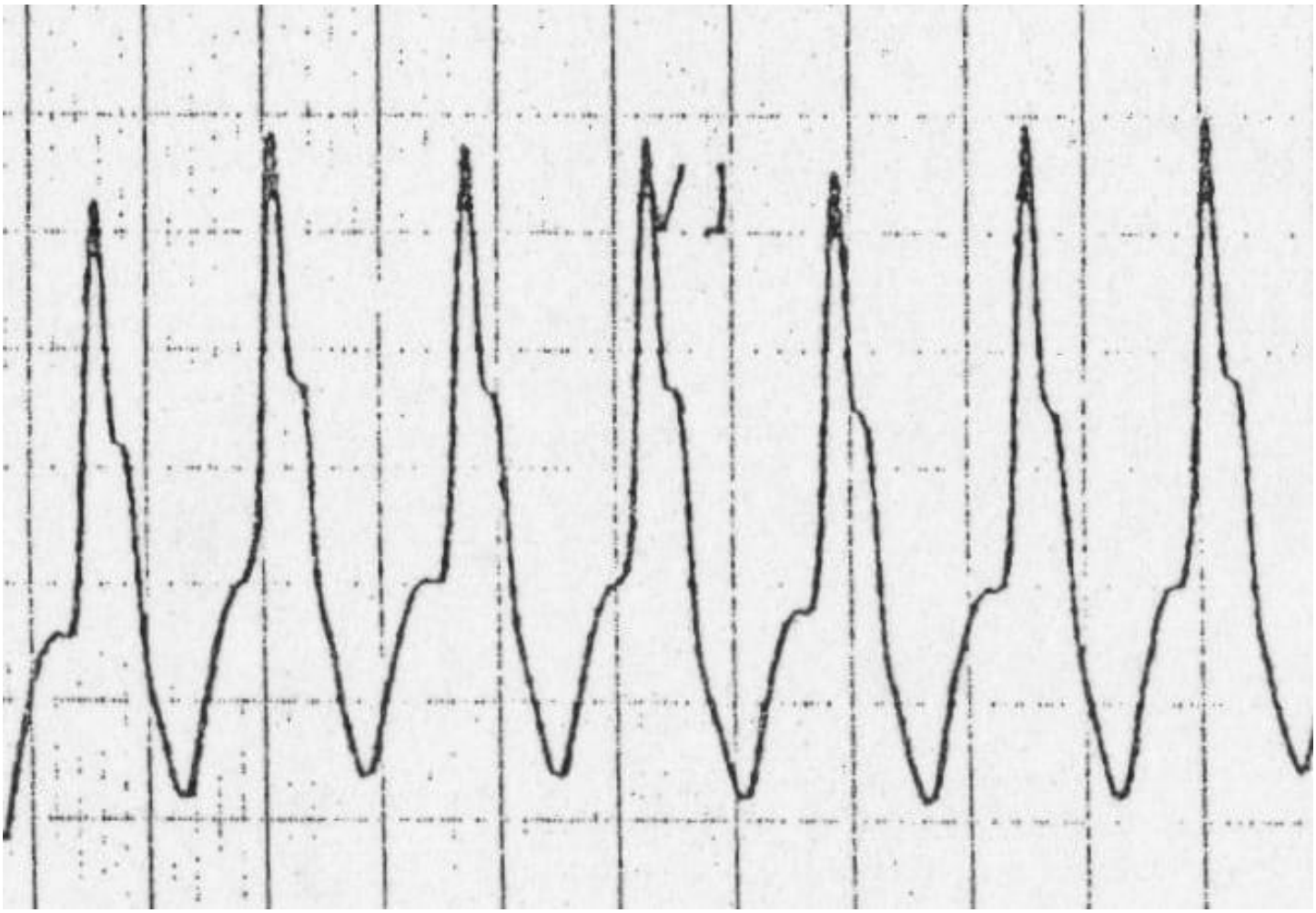
Negative concordance throughout the precordial leads:



Negative concordance in VT: Leads V1-6 show entirely negative (QS) complexes, with no rS complexes seen

RSR' complexes with a taller left rabbit ear:

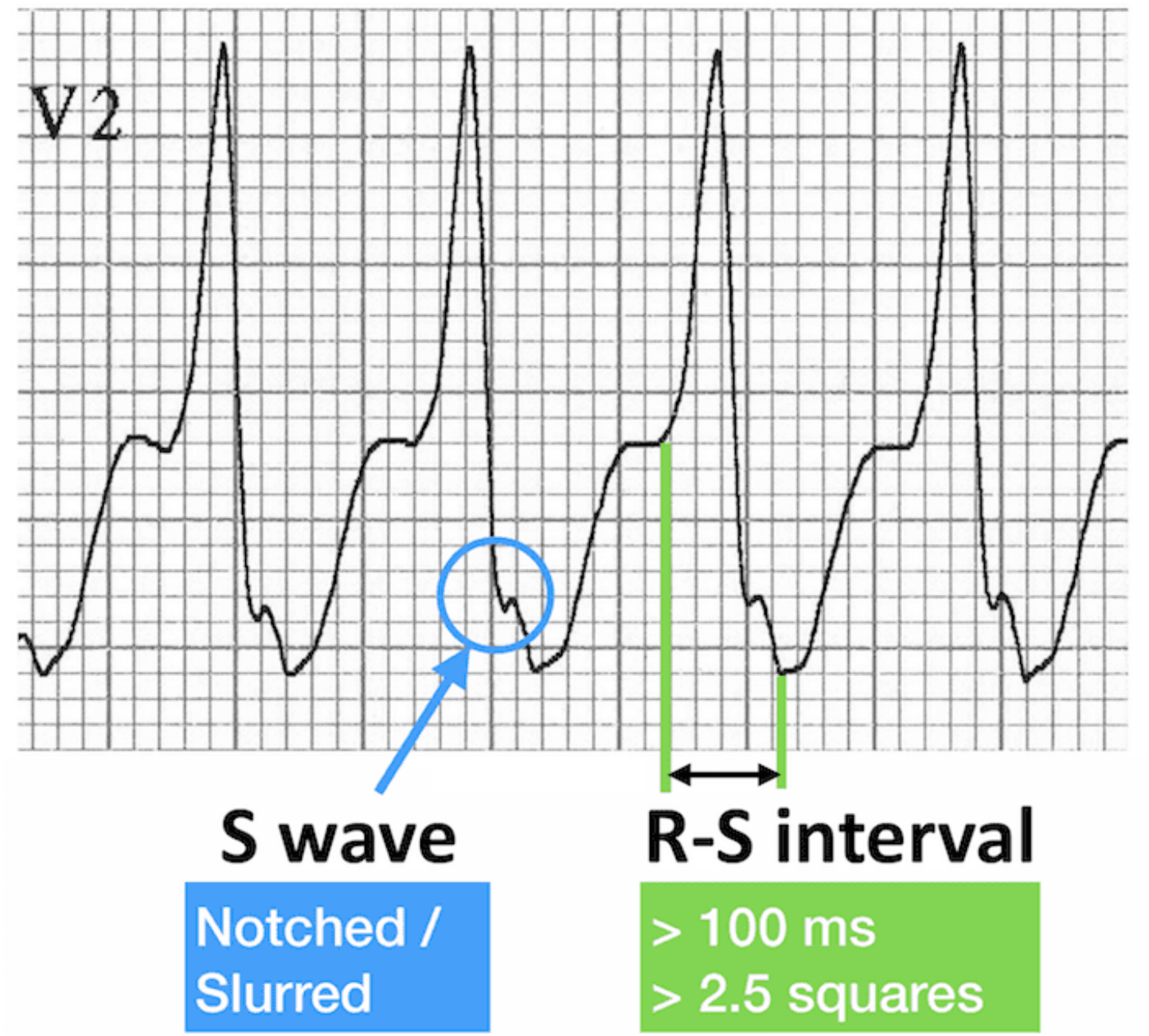
- This is the most specific finding in favour of VT
- This is in contrast to RBBB, where the right rabbit ear is taller



Taller left rabbit ear in V1

Brugada sign: Distance from onset of R wave to nadir of S wave is > 100ms in leads V1-6 (discussed further below)

Josephson sign: Notching/slurring near the nadir of the S wave



Lead V2 demonstrating both **Josephson sign** (blue) and **Brugada sign** (green)

Clinical factors associated with VT or SVT

The likelihood of VT is increased with:

- Age > 35 (positive predictive value of 85%)
- Structural heart disease
- Ischaemic heart disease
- Previous MI
- Family history of sudden cardiac death (suggesting conditions such as HOCM, congenital long QT syndrome, Brugada syndrome or arrhythmogenic right ventricular dysplasia that are associated with episodes of VT)

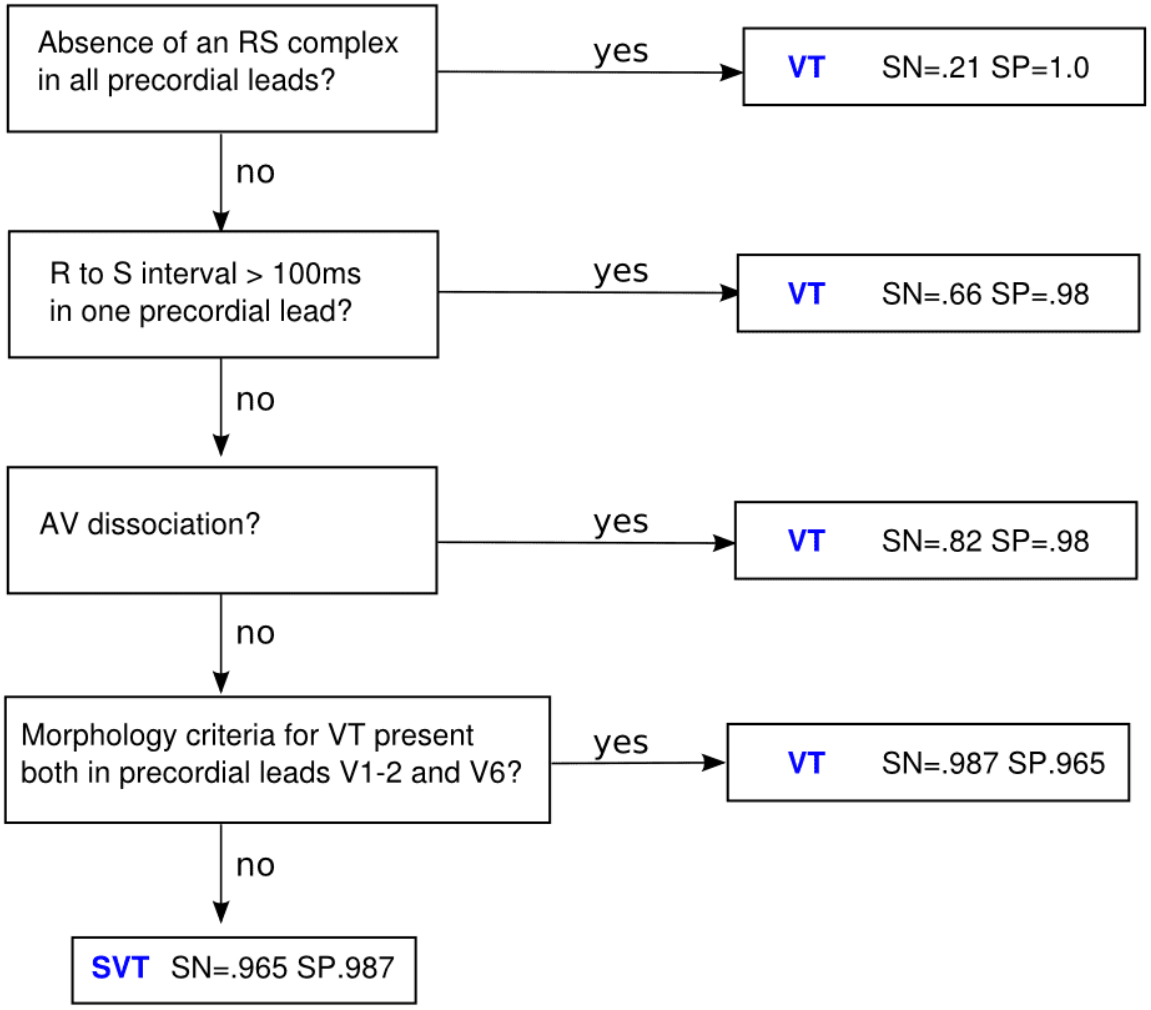
The likelihood of SVT with aberrancy is increased if:

- Previous ECGs show a bundle branch block pattern with identical morphology to the broad complex tachycardia
- Previous ECGs show evidence of WPW (short PR < 120ms, broad QRS, delta wave)
- The patient has a history of paroxysmal tachycardias that have been successfully terminated with adenosine or vagal manoeuvres

Advanced Tips for Diagnosing VT — The Brugada Criteria

- For difficult cases, the Brugada algorithm can be used to distinguish between VT and SVT with aberrancy.
- The algorithm is followed from top to bottom — if any of the criteria are satisfied, then VT is diagnosed.

Brugada Algorithm



1. Absence of an RS complex in all precordial leads

This is essentially the same as having positive or negative concordance.

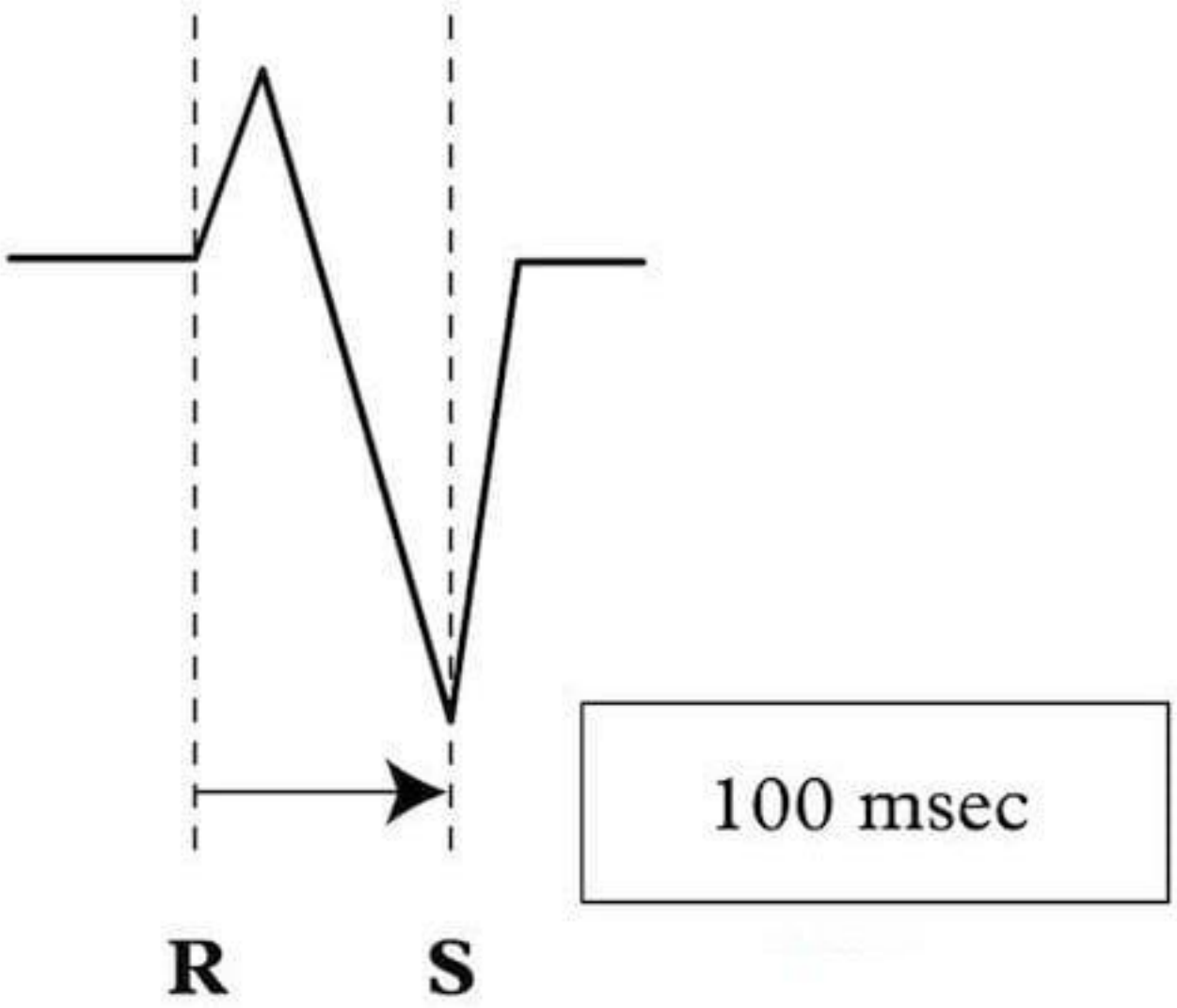
- All precordial leads consist of either monophasic R or S waves
  - → VT is diagnosed
- If there are any RS complexes present in V1-6
  - → go to step 2

Precordial R waves only → VT
Precordial S waves only → VT
RS complexes present → go to step 2

2. RS interval > 100ms in one precordial lead

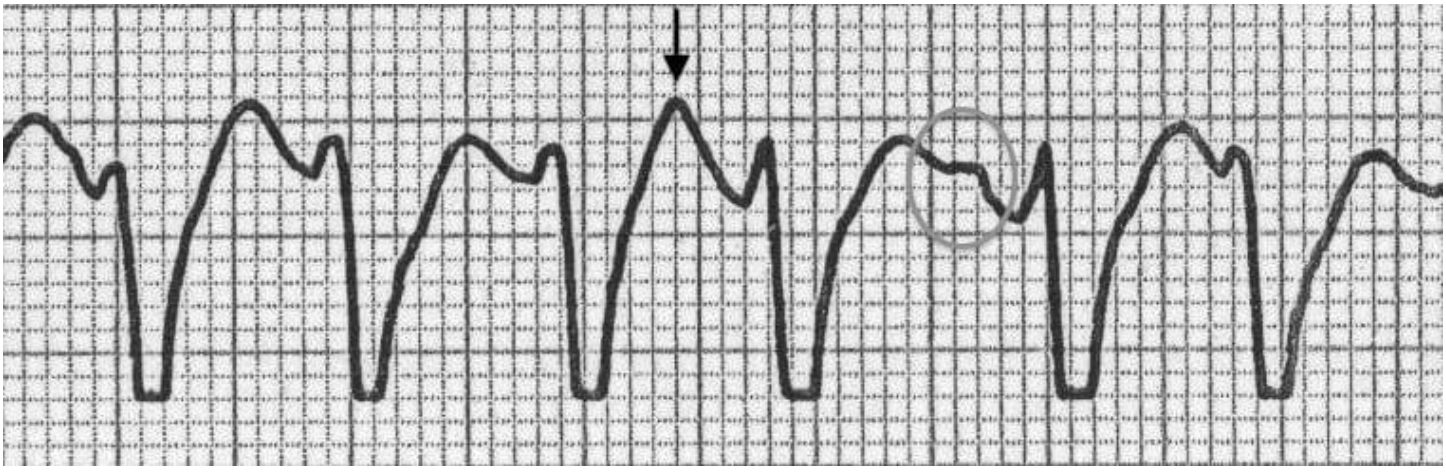
If RS complexes are present in V1-6 then the RS interval is measured. This is the time from the **onset of the R wave to the nadir of the S wave**.

- If the RS interval is **> 100 ms**
    - → **VT**
- If the RS interval is **< 100 ms**
    - → **go to step 3**



3. AV dissociation

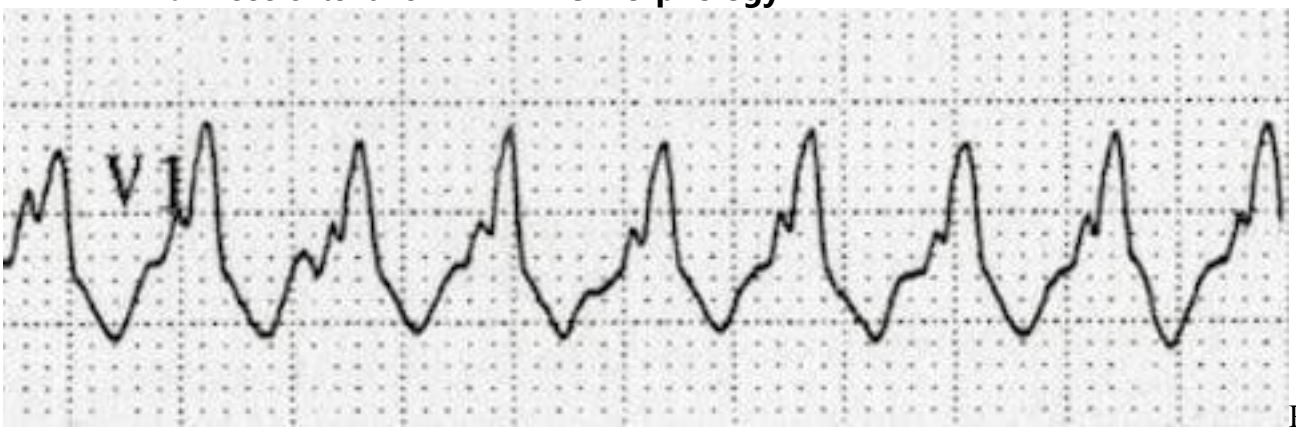
- P waves are present at a different rate to the QRS complexes
    - → AV dissociation is present and **VT is diagnosed**.
- No evidence of AV dissociation can be seen
    - → **go to step 4**



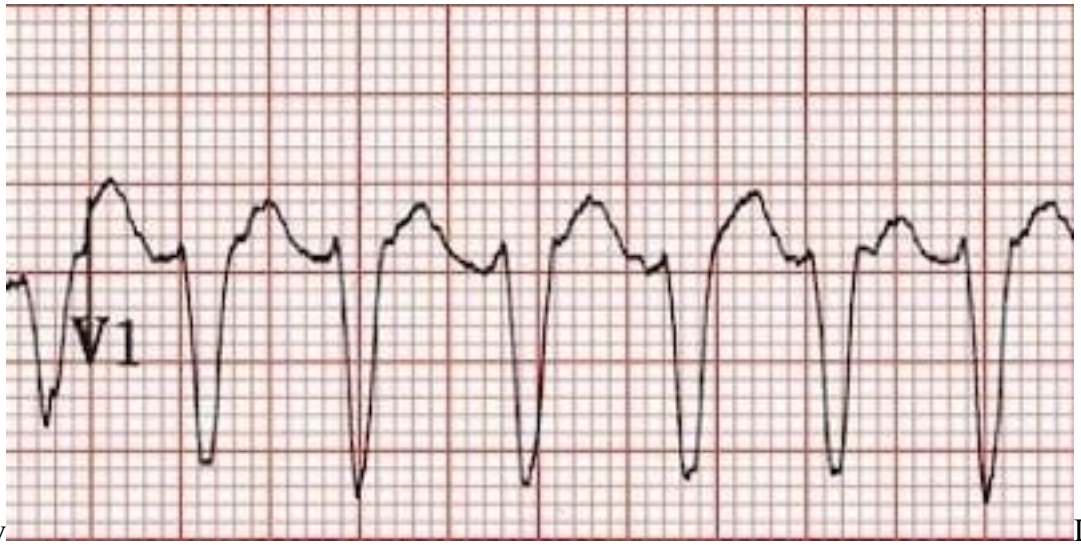
4. Morphological Criteria for VT

Leads V1-2 and V6 are assessed for characteristic features of VT. There are two sets of morphological criteria depending on the appearance of the QRS complex in V1:

- **Dominant R wave in V1**
    - → see criteria for **RBBB-like morphology**
- **Dominant S wave in V1**
    - → see criteria for **LBBB-like morphology**



RBBB-like morphology



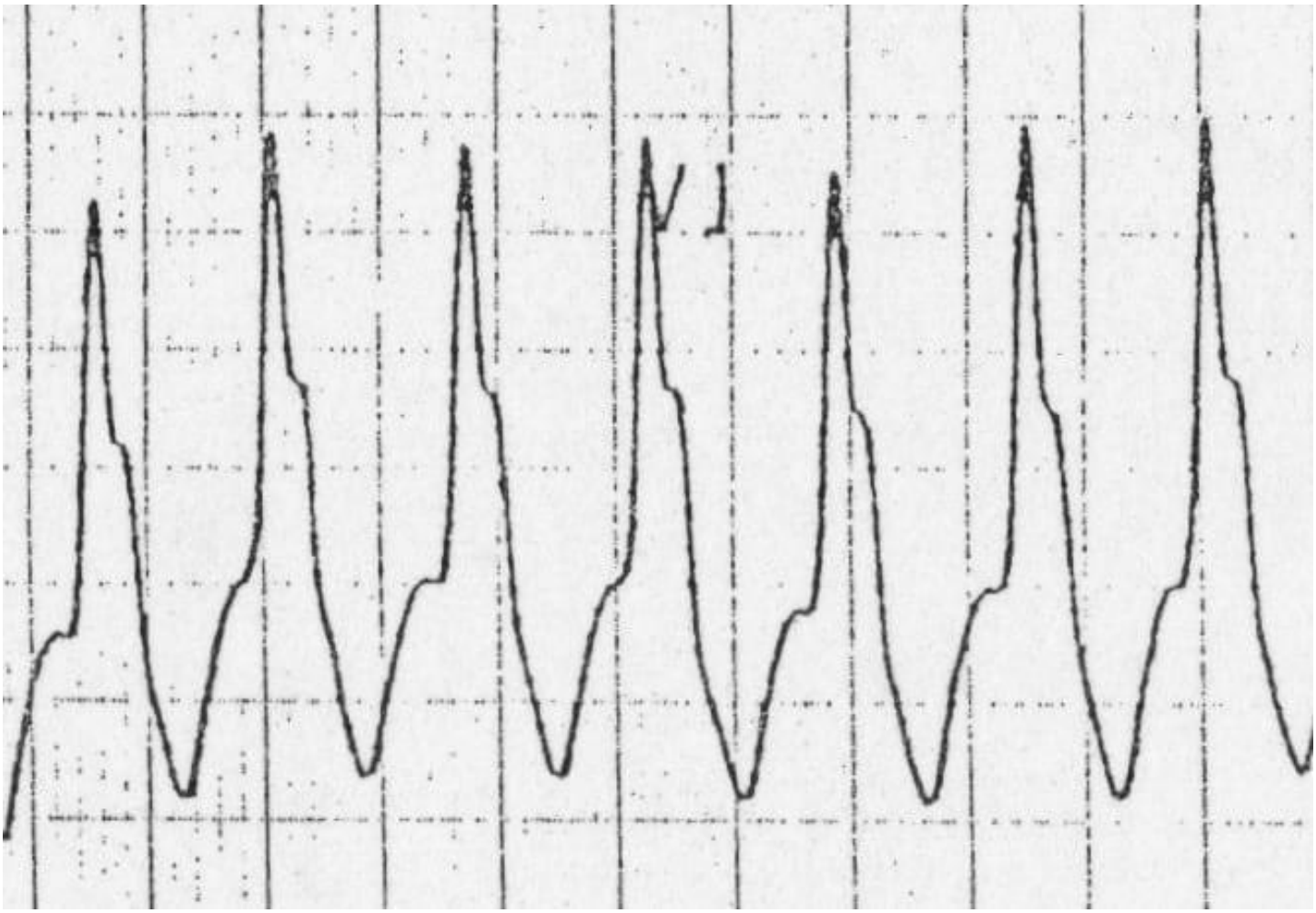
LBBB-like morphology

Broad complex tachycardia with RBBB morphology

Appearance in V1-2

With a positive R wave in V1/V2, three patterns are indicative of VT:

- Smooth **monophasic R wave**
- Notched downslope to the R wave — the taller **left** rabbit ear
- A **qR** complex (small Q wave, tall R wave) in **V1**

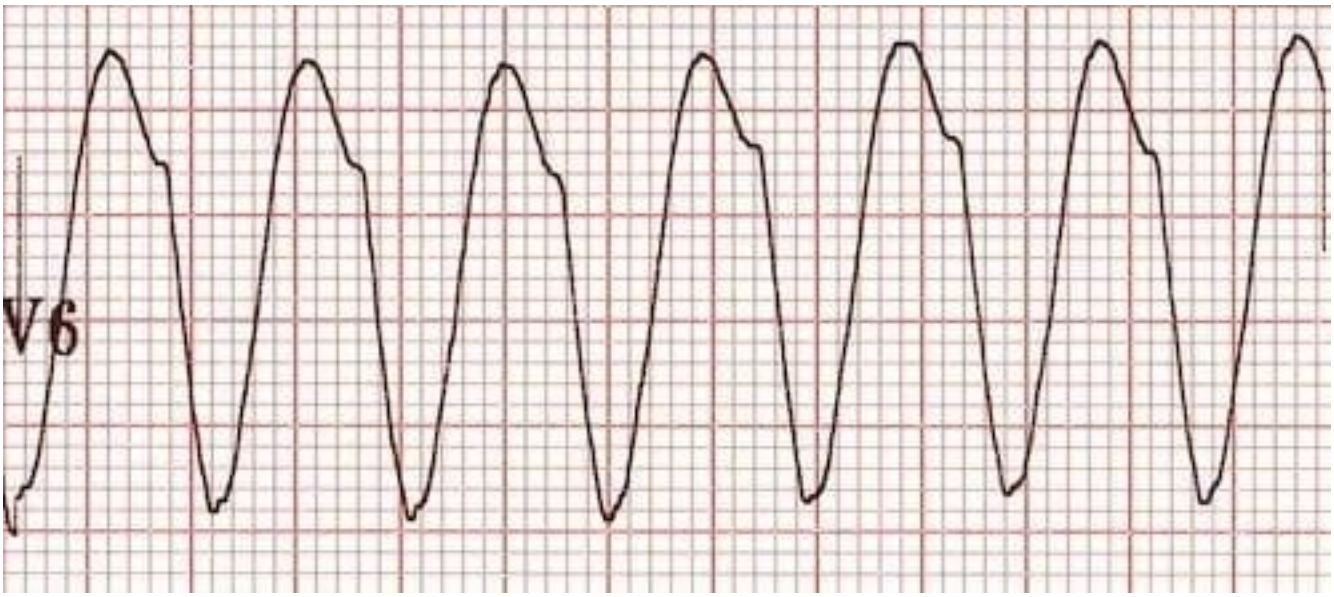


Notched downslope to R wave: taller **left** rabbit ear indicating VT
NOTE: RSR' pattern is suggestive of SVT with RBBB

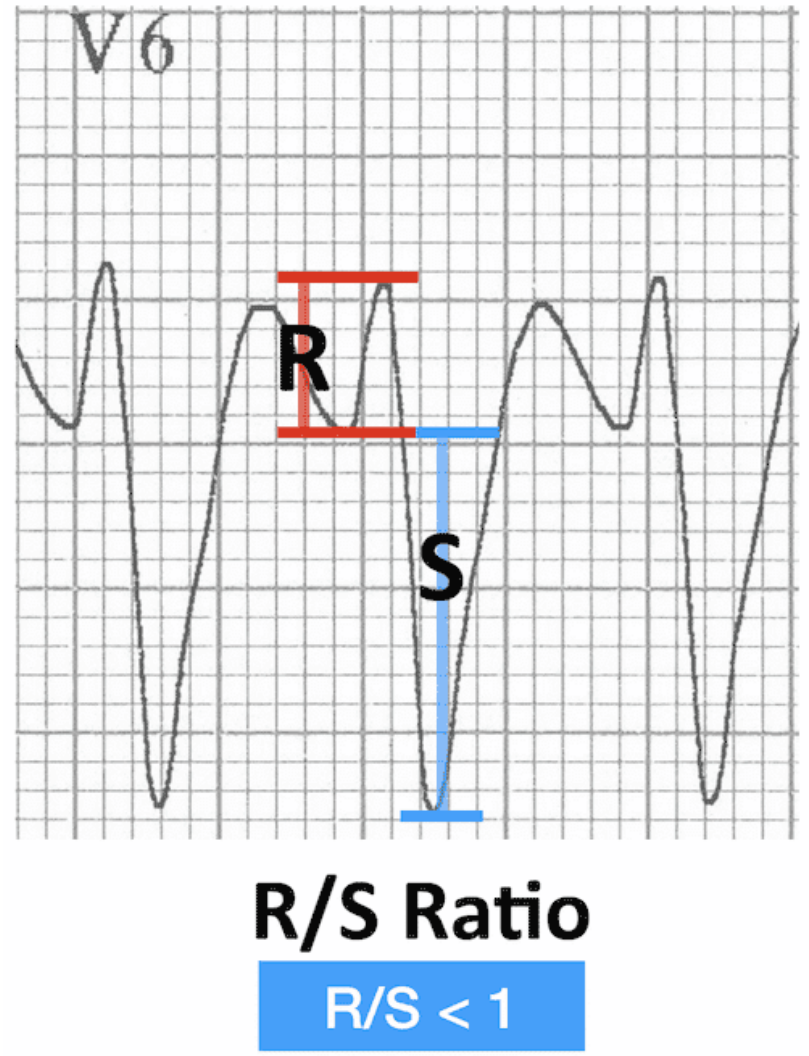
Appearance in V6

In V6, the following patterns are **consistent with VT**:

- **QS complex**
  - Completely negative complex with no R wave



- **R/S ratio < 1**
  - Small R wave, deep S wave
  - Indicates VT *only* if LAD is also present



Broad complex tachycardia with LBBB morphology

Appearance in V1-2

With a dominant S wave in V1, the following three features are diagnostic of VT:

- Initial R wave > 30-40 ms duration.
- Notching or slurring of the S wave (Josephson sign)
- RS interval (time from R wave onset to S wave nadir) > 60-70 ms

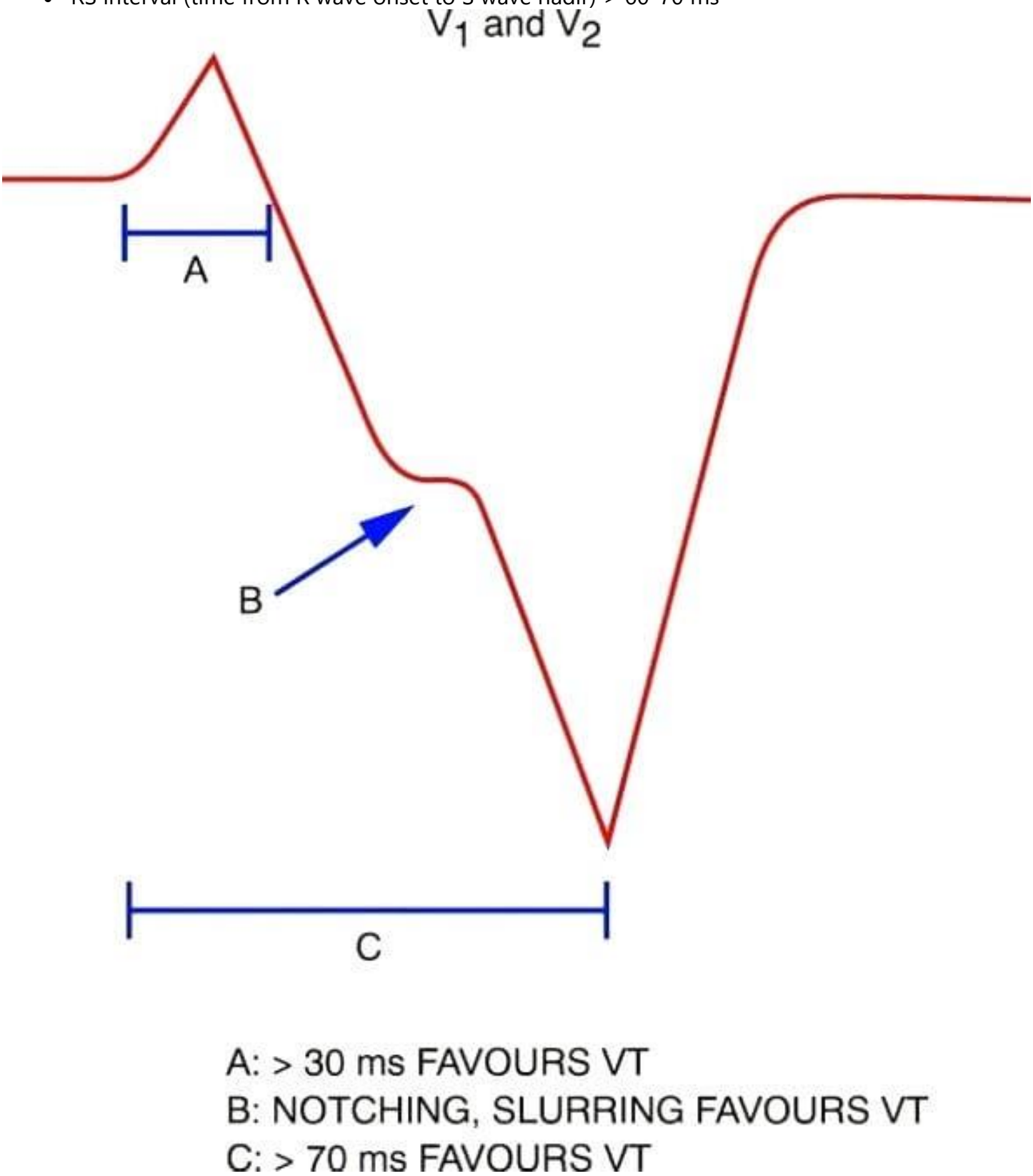
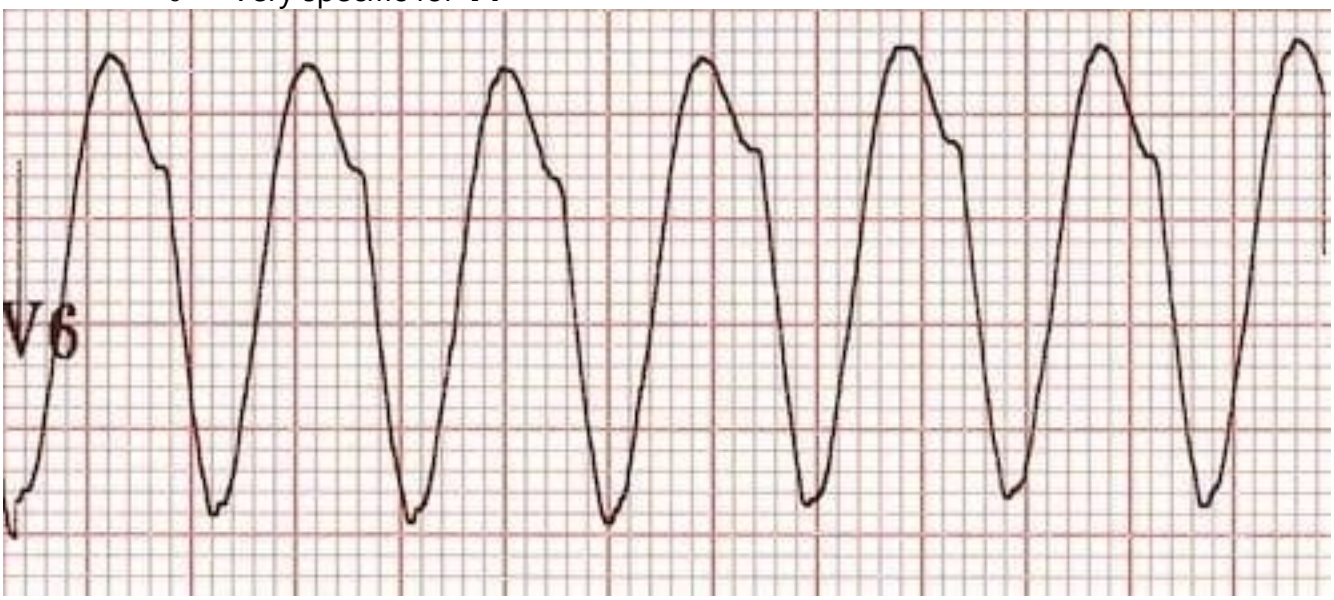


Image reproduced from Wellens (2001)

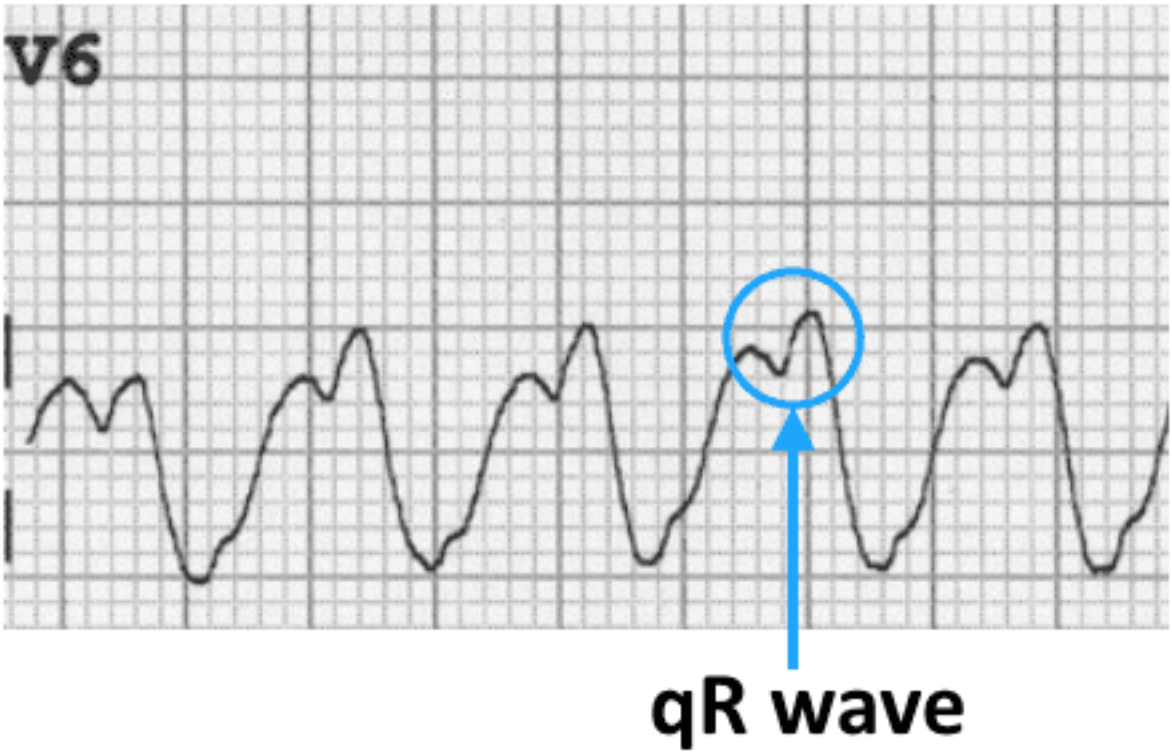
Appearance in V6

With a LBBB-like pattern, the presence of Q waves in V6 is indicative of VT.
There are two possible patterns of this:

- **QS waves** in V6 (as with RBBB-like patterns)
    - → Very specific for **VT**



- **qR complex** in V6 (small q wave, large R wave)
    - → **VT**

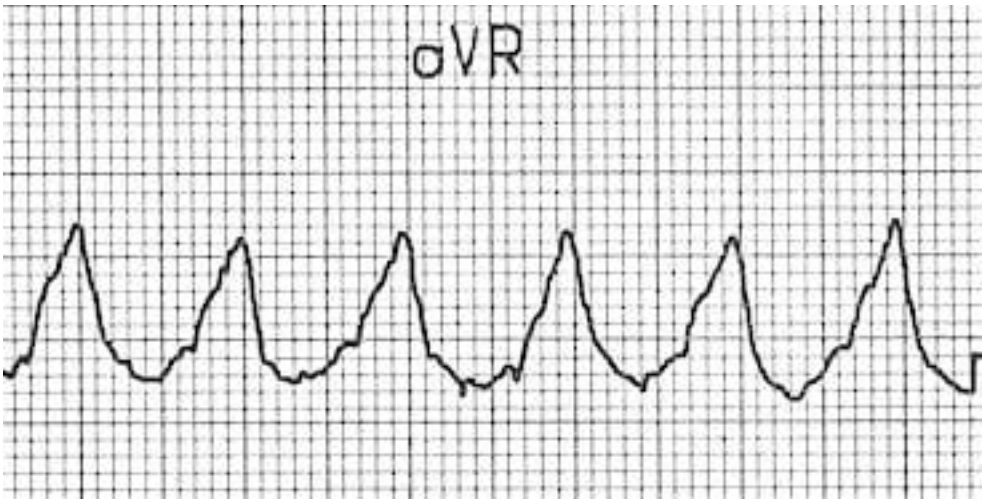


Note: SVT with LBBB is associated with absent Q waves in V6.

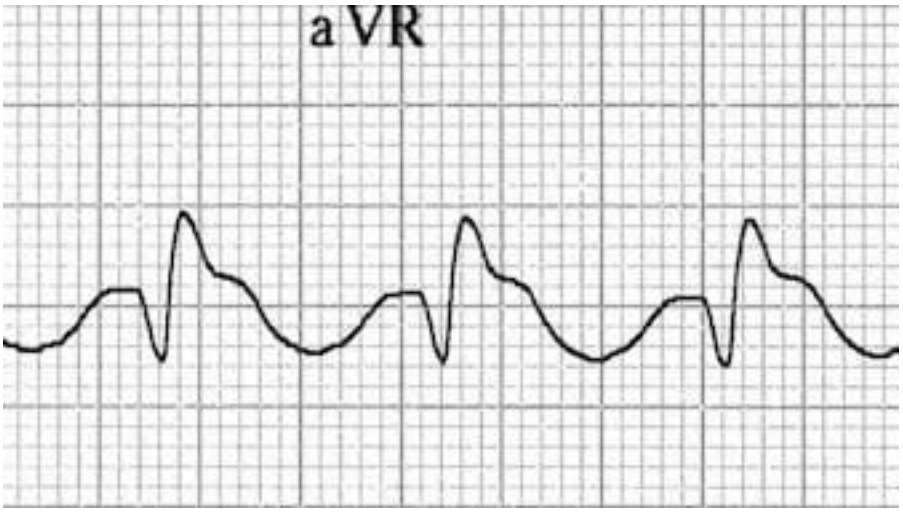
More Advanced Tips — The Vereckei Algorithm

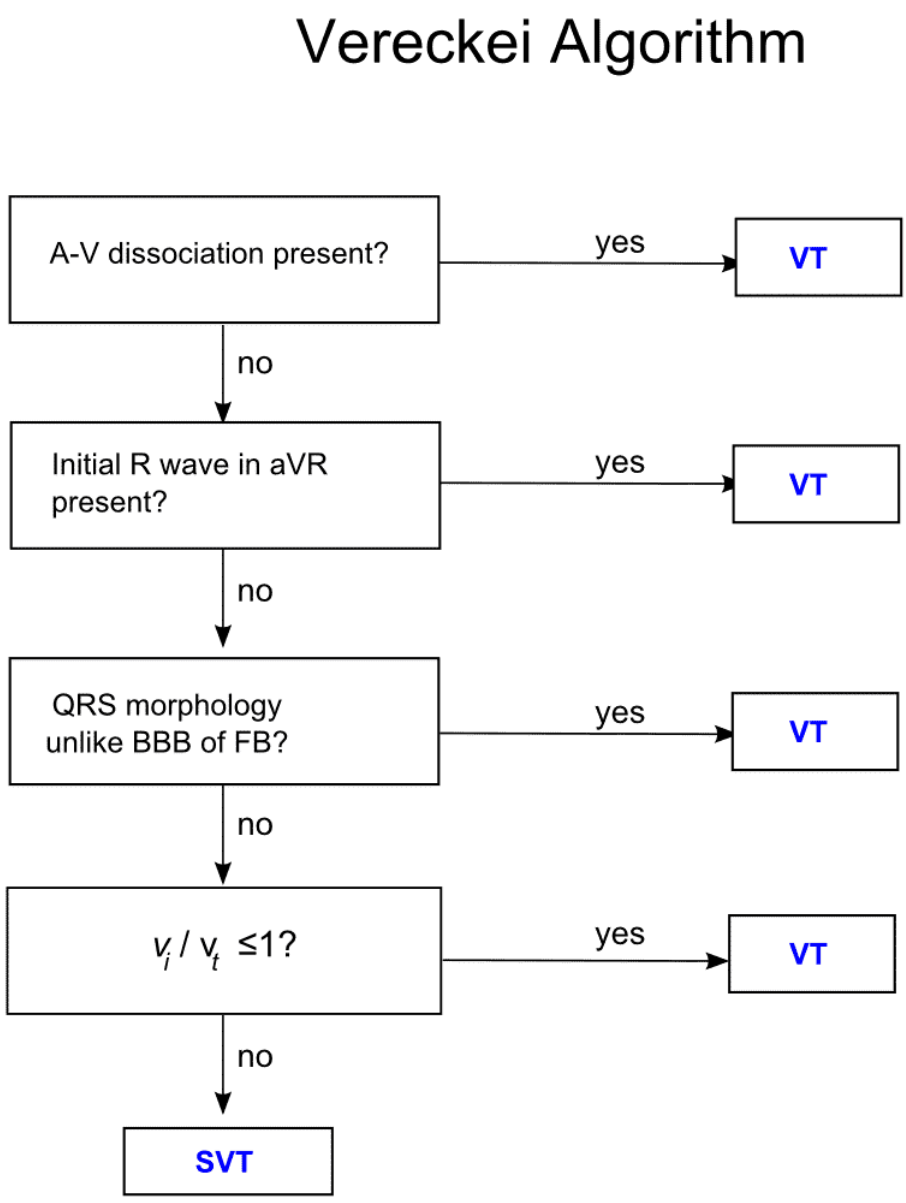
There is some overlap between the Vereckei and Brugada algorithms, but one of the most useful tips from the Vereckei algorithm is to examine the QRS complex in lead aVR. [PMID 18180024]

- Dominant initial R wave in aVR
    - Indicative of VT



- **Dominant *terminal* R' wave in aVR** (i.e. following a Q/S wave)
    - More likely **SVT with aberrancy**
    - Pattern is most commonly seen in TCA toxicity


aVR



Other diagnostic algorithms

- Ultrasimple Brugada criterion: RW to peak Time (RWPT)
- The ACC algorithm

Conclusions

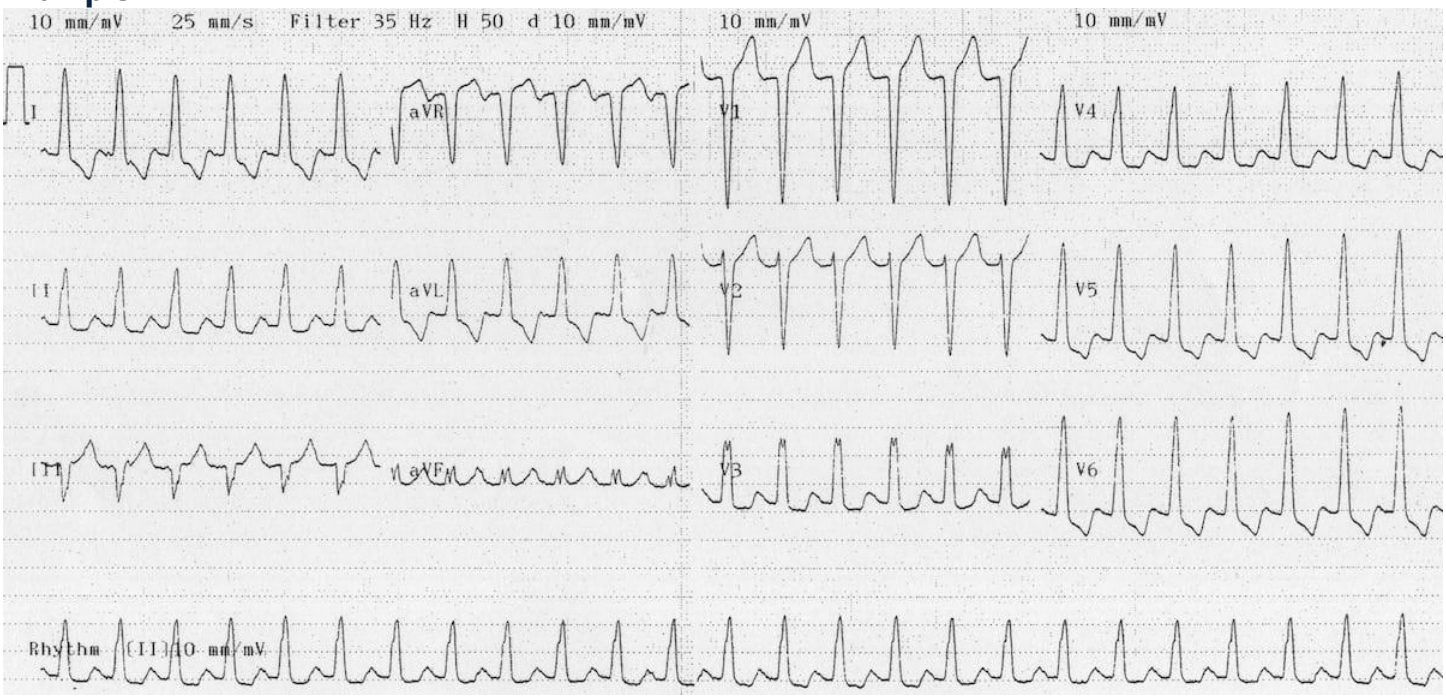
- Most of the published criteria have high specificities but very low sensitivities (e.g. 20-50%) for diagnosing VT

- This means that even in the absence of diagnostic features for VT, there is no way to be 100% certain that the rhythm is SVT with aberrancy…
- ***If in doubt, treat as VT!***

Broad Complex Tachycardia Quiz

Test your skills with these broad complex rhythms…

Example 1



Reveal answer

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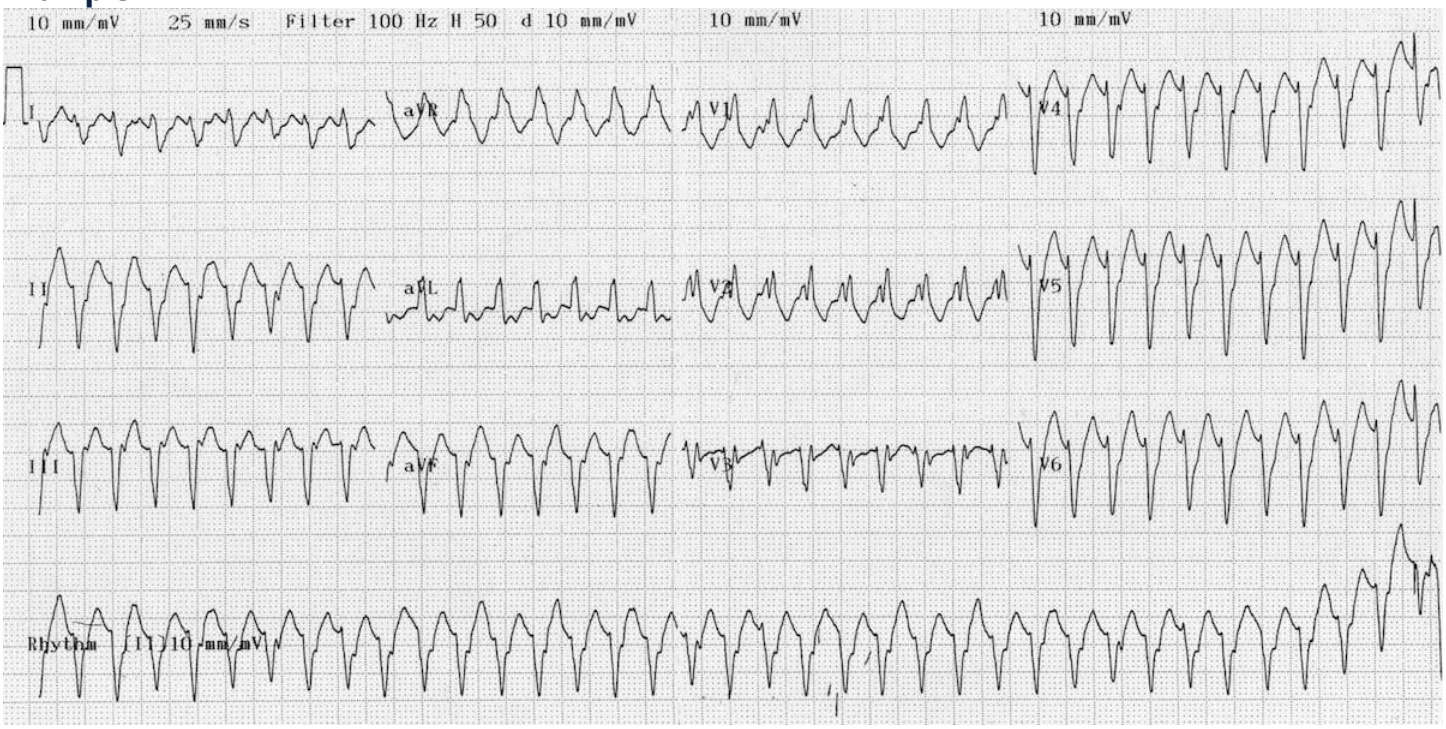
Example 2



Reveal answer

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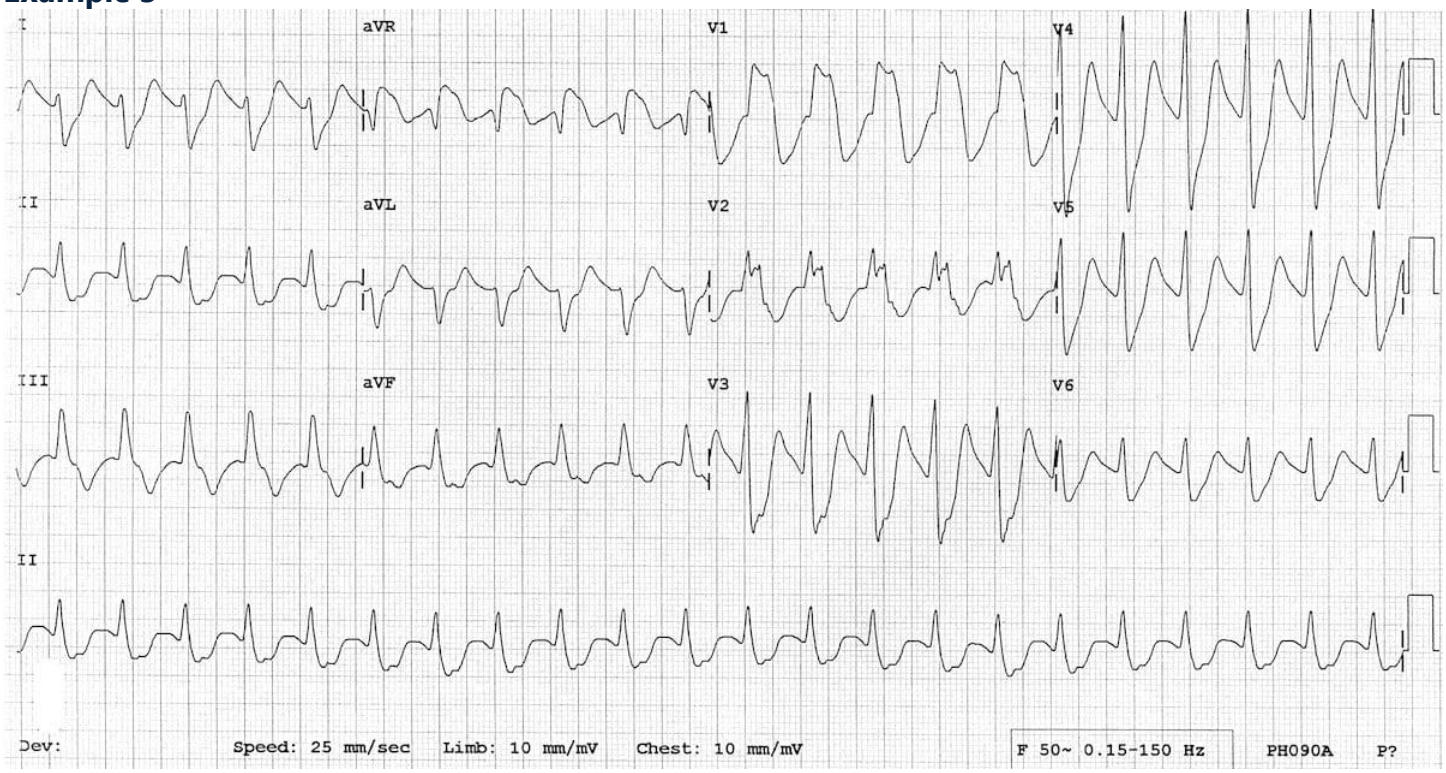
Example 3



Reveal Answer

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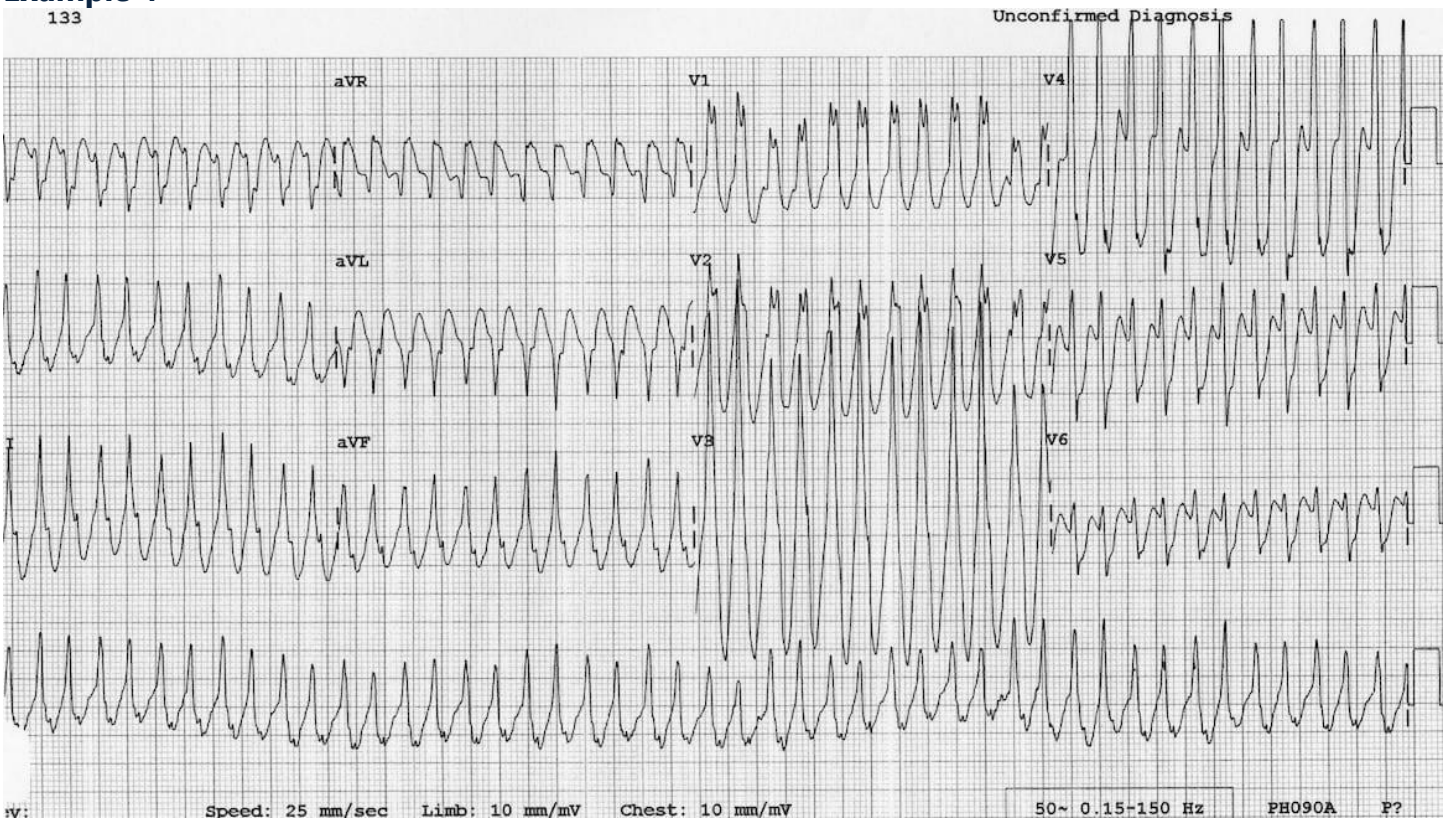
Example 4



...Clue

Reveal Answer

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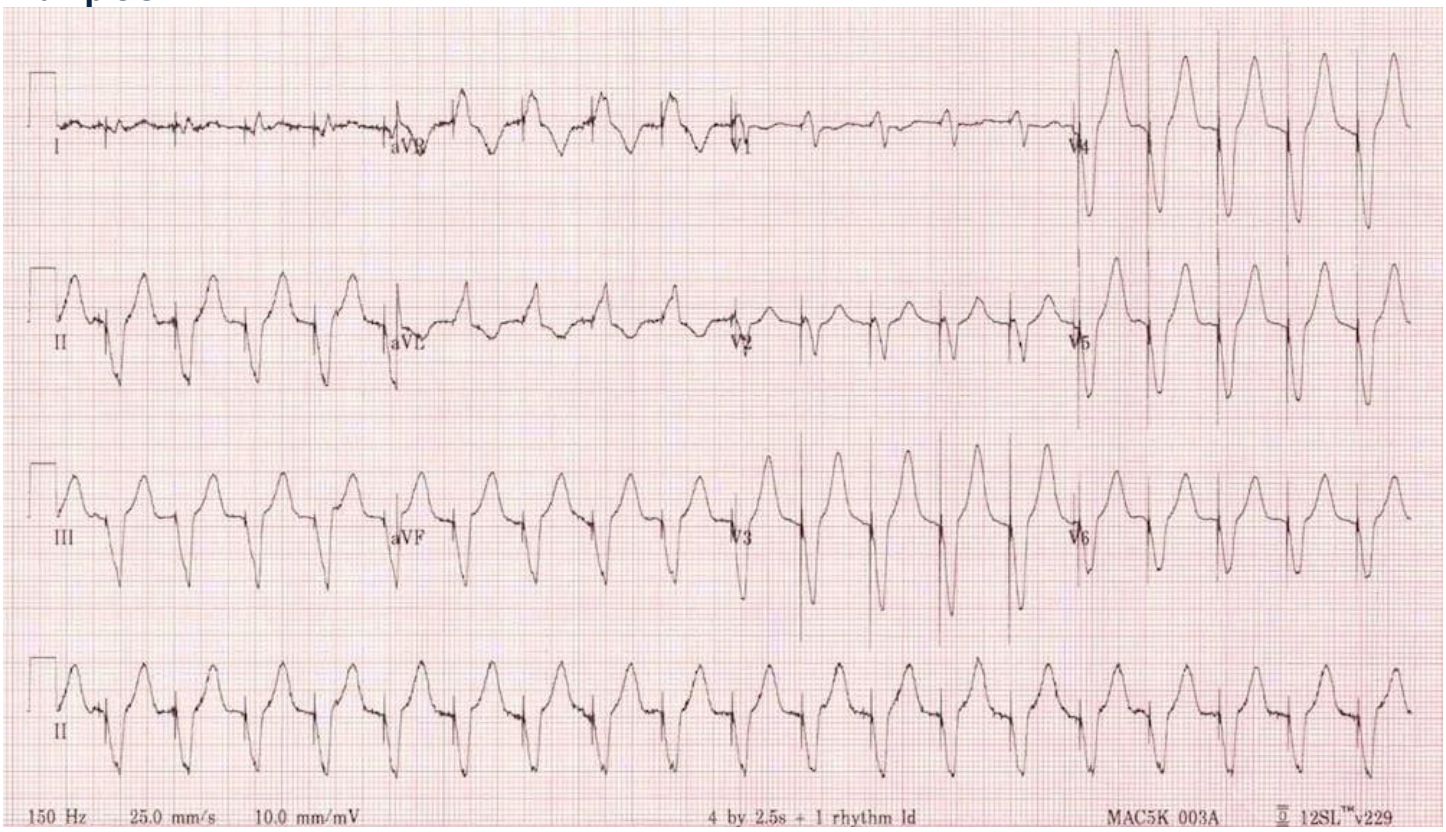
Example 5



Reveal Answer

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Further reading

- Read a detailed review article on VT versus SVT by ECG guru Prof Hein Wellens (of eponymous syndrome fame!)
- See some more ECG examples of ventricular tachycardia from the LITFL ECG library.
- ECG Top 100 – Clinical Case 046 (RBBB morphology)
- ECG Top 100 – Clinical Case 046 (LBBB morphology)
- ECG Exigency 004 – a case of broad complex tachycardia.

Related Topics

Read more about the different types of VT by following these links:

- Monomorphic VT
- Right Ventricular Outflow Tract Tachycardia
- Polymorphic VT / Torsades De Pointes
- Fasicular Tachycardia
- Bidirectional VT
- Ventricular Flutter

References

- Wellens HJ. Electrophysiology: Ventricular tachycardia: diagnosis of broad QRS complex tachycardia. Heart. 2001 Nov;86(5):579-85.
- Alzand BS, Crijns HJ. Diagnostic criteria of broad QRS complex tachycardia: decades of evolution. Europace. 2011 Apr;13(4):465-72.
- Brugada P, Brugada J, Mont L, Smeets J, Andries EW. A new approach to the differential diagnosis of a regular tachycardia with a wide QRS complex. Circulation. 1991 May;83(5):1649-59 [**Brugada criteria**]
- Josephson ME et al. Sustained ventricular tachycardia: role of the 12-lead electrocardiogram in localizing site of origin. Circulation. 1981 Aug;64(2):257-72 [**Josephson sign**]
- Kindwall KE, Brown J, Josephson ME. Electrocardiographic criteria for ventricular tachycardia in wide complex left bundle branch block morphology tachycardias. Am J Cardiol. 1988 Jun 1;61(15):1279-83 [**Josephson sign**]
- Vereckei A, Duray G, Szénási G, Altemose GT, Miller JM. Application of a new algorithm in the differential diagnosis of wide QRS complex tachycardia. Eur Heart J. 2007 Mar;28(5):589-600 [**Vereckei algorithm**]
- Vereckei A. Current algorithms for the diagnosis of wide QRS complex tachycardias. Curr Cardiol Rev. 2014 Aug;10(3):262-76

LITFL Further Reading

- ECG Library Basics – Waves, Intervals, Segments and Clinical Interpretation
- ECG A to Z by diagnosis – ECG interpretation in clinical context
- ECG Exigency and Cardiovascular Curveball – ECG Clinical Cases
- 100 ECG Quiz – Self-assessment tool for examination practice
- ECG Reference SITES and BOOKS – the best of the rest

Advanced Reading

- Brady WJ, Truwit JD. Critical Decisions in Emergency and Acute Care Electrocardiography
- Surawicz B, Knilans T. Chou's Electrocardiography in Clinical Practice: Adult and Pediatric
- Wagner GS. Marriott's Practical Electrocardiography 12e
- Chan TC. ECG in Emergency Medicine and Acute Care
- Rawshani A. Clinical ECG Interpretation
- Mattu A. ECG's for the Emergency Physician
- Hampton JR. The ECG In Practice, 6e